TITLE: Monitoring Mountain Pine Beetle Life Cycle Timing and Phloem Temperatures at Multiple Elevations and Latitudes in California

LOCATION: California - Lassen National Forest, Lake Tahoe Basin Management Unit, Inyo National Forest, Tahoe National Forest and San Bernardino National Forest

DATE: Original-September 24, 2008; Progress-September 15, 2009

DURATION: Year 2 of 3-year project FUNDING SOURCE: Base

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PROJECT OBJECTIVES: 1) To develop a baseline database of mountain pine beetle (Dendroctonus ponderosae) (MPB) life cycle timing and associated phloem temperatures in several host trees at multiple elevations and latitudes across California (CA). 2) Using the field-collected data, evaluate current mountain pine beetle phenology models for improved climate change risk assessment in CA.

JUSTIFICATION:

Linkage to FHM Detection Monitoring: Based on FHM aerial detection surveys, over 180,000 MPB host trees were killed in 2007 across 40,000 acres in CA, an increase from previous years. MPB-caused tree mortality was also documented in ground surveys conducted by Forest Health Protection personnel (CA Forest Pest Conditions 2007 Report), and in upper montane and subalpine forests being monitored as part of an EM-funded project (Dunlap, Maloney and Jensen).

Significance: Mountain pine beetle is at outbreak levels across western North America, significantly impacting millions of forested acres. One causal factor driving MPB expansion and rapid population growth is climate change. Mountain pine beetle activity in CA is expected to significantly increase as climate change-associated drought conditions persist and temperatures increase, putting many high elevation and high-value species in CA at risk.

Biological impact: Mountain pine beetle host species occur across a large elevational gradient (~2,000 to ~12,000+ ft) in CA, although little data is available on MPB population and outbreak dynamics. Increasing levels of MPB-caused tree mortality have been detected in a number of hosts including lodgepole, foxtail, whitebark, western white, piñon and sugar pine. Data obtained from this project will be used for improved outbreak predictions, provide key information for risk-rating high elevation pines in CA and the western US, and to potentially set priorities for management.

Scientific Basis/Feasibility: Project personnel bring a diverse array of skills to the project, including the study of MPB phenology in the laboratory and field, monitoring bark beetle populations in CA, and knowledge of CA forests including sensitive and long-lived high elevation pine systems. This project will use established and proven techniques to obtain quantitative information on MPB phenology.

Priority Issues: This project addresses several priority areas including: 1) climate change effects on insects, 2) validating or filling data gaps in insect risk models, 3) deviations from expected levels of tree mortality and 4) drought.
DESCRIPTION:

a. Background: Climate change-associated temperature increase is a significant factor influencing recent increases in MPB population success (Bentz et al. 2008). In particular, high elevation white pine forests are being severely impacted because significant temperature changes are occurring at these elevations. Our knowledge about MPB lifestage-specific response to temperature, including data used for parameterization of a MPB phenology model (Bentz et al. 1991, Regniere et al. 2008), is derived almost entirely from one area in central Idaho. Yet, we know that MPB response to temperature varies depending on latitude and elevation (Bentz et al. 2001, Bracewell and Bentz unpub data). For example, in a common garden experiment at a constant 22°C, MPB from southern CA (San Bernardino NF) required > 25% longer to develop than did MPB from northern CA (Lassen NF). Some have speculated that MPB may have two generations per year at lower elevations in CA, yet no data is available to evaluate this or any other aspect of MPB population life cycle timing in CA. Baseline data is needed on MPB life cycle timing to assess future climate-change associated risk to CA’s pine forests. CA is home to six of the nine white pine species native to the U.S. Many of these are keystone, long-lived species growing at high elevations and are also threatened by white pine blister rust (Maloney et al. In review). We propose to collect baseline information on MPB life cycle timing in several host tree species, at multiple elevations and latitudes throughout CA. This information is essential for evaluation of current MPB models, improved risk assessment, and management priority setting.

b. Methods: We selected four areas in CA to monitor MPB lifecycle timing, air temperature, and phloem temperatures of infested host trees. Sites have current MPB activity, and were chosen to allow a gradient of elevation with multiple host tree species from northern to southern CA: 1) North Sierra Nevada-South Cascades Region: Lassen National Forest; 2) North-central Sierra Nevada Region: three sites, Tahoe National Forest and the Lake Tahoe Basin Management Unit; 3) Southern Sierra Nevada Region: Inyo National Forest and 4) Southern CA Region: San Bernardino National Forest.

Data on MPB phenology will be collected using established field methodology (Bentz and Mullins 1999). At each site, a datalogger (Campbell Scientific Inc., Logan, UT) will be installed to collect phloem temperature measurements of four MPB-infested trees and air temperature every 10 minutes for the duration of the MPB life cycle. We anticipate 1 or 2 years will be required to complete a generation, depending on elevation. At low elevations, some populations may require < 1 year to complete a generation. The timing of MPB attack will be measured on the lower 5 ft. of each tree at each site on a daily basis. At the end of the cycle, MPB adult emergence timing will be monitored on a daily basis using emergence cages attached to the tree bole (see Bentz 2006). We propose to monitor two MPB generations at each site, June 2009 – August 2010 and June 2010 – August 2011. These data will provide a quantification of MPB life cycle timing and associated temperatures in several forest ecosystems in CA, and will also be used in climate change risk assessment for CA.

c. Products: Peer-reviewed publication on MPB life cycle timing and associated temperatures in multiple host trees in CA. Validation of MPB phenology model(s). Dissemination of project results at local and national meetings.

d. Schedule of Activities: Project is on track per original schedule of activities

2009 Early summer: installed dataloggers and temperature probes at each site.
June/July/August – monitored MPB attacks.
October – install emergence cages and check for bivoltine populations.

2010 June-September – monitor MPB emergence from 2009-attacked trees.
June/July – monitor MPB attacks on 2010-attacked trees.

2011 June-September – monitor MPB emergence from 2010-attacked trees.

e. Progress/Accomplishments:

YEAR 1: In 2009 plots were established at 6 sites in 4 general areas across CA representing a range of latitude, elevation, and mountain pine beetle host tree species: 1) Lassen NF: sugar pine in the Elam
vicinity (5364 ft); 2) Tahoe NF and Lake Tahoe Basin Management Unit: lodgepole pine in the Prosser Creek area (5847 ft), western white pine and lodgepole pine near Incline Lake (8540 ft), and whitebark pine near Relay Peak in the Mount Rose region (9619 ft); 3) Inyo NF: foxtail pine on Granite Pass near Horseshoe Meadow (9600 ft); and 4) San Bernardino NF: piñon pine near Big Bear Lake (6822 ft).

Sites for plot establishment were chosen based on the level of MPB activity and available host trees. At each site, phloem temperature probes were installed on 3 to 5 trees on the north and south bole aspect at DBH. To initiate MPB attack on these probed trees, an aggregation pheromone pouch was placed on each tree until ~20 MPB attacks had occurred. The pouch was then removed to allow the natural attack process to progress. The number and timing of MPB attacks were monitored on each tree (between 1 ft and 5 ft above ground level) on a daily or weekly basis depending on site. Air temperature probes were also installed at each site. A datalogger at each site will collect and store air and phloem temperatures throughout the year (on a 10 minute interval). In October 2009, emergence cages will be placed on up to 5 MPB-infested trees at each site. Samples will be taken from infested trees at each site to monitor MPB developmental timing. Also at this time, temperature data (to date) will be downloaded and dataloggers prepared for continual collection of data through beetle emergence in 2010.

In summer 2010, emergence timing from temperature probed/caged trees will be monitored. Because the timing of brood and potential re-emerging adults is unknown for these areas, monitoring will be initiated early in the spring and continue through the summer. At each site newly attacked trees will be monitored as before, and phloem temperature probes installed for monitoring the next generation. We also plan to install temperature probes and monitor mountain pine beetle activity at a site on the Klamath NF in 2010.

**f. Budget:**
A total of $26,220 is requested for FY2010 in addition to approximately $10,000 of FY2009 monies being returned to the project as carryover to facilitate the remainder of the work to be accomplished in the fall of 2009.

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Literature Cited available upon request.